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ABSTRACT

Two methods for presentation of programed diagnostic tests were compared. One method used a five-screen, tape and slide format and the other used television in the form of videotape recording. The electronics course used for the study employed 10 diagnostic tests, five for each method. Evaluation was made on the basis of test scores and attitude tests. There was no significant difference in the measuring capacity of the two methods, but the students' attitudes, as measured by direct questions and attendance figures, favored the tape/slide form of presentation. (Author/JK)

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REPORT PE-10

A COMPARISON BETWEEN TWO METHODS FOR DISPLAY OF PROGRAMMED DIAGNOSTIC TESTS

Department of Education, KTH

JANUARY 1971
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Report No. PE-10

A COMPARISON BETWEEN TWO METHODS FOR DISPLAY OF PROGRAMMED DIAGNOSTIC TESTS

EM 008 935

January, 1971

Peter Graham

This project has been carried out in cooperation with the Department of Educational and Psychological Research at the Stockholm School of Education and has been financially supported by the Commission for Television and Radio in Education.

Summary

This report describes a special study of different methods for presentation of programmed diagnostic tests.

The study was carried out on an electronics course with integrated feed-back during the spring of 1969.

Two methods for presentation of programmed diagnostic tests were compared. One method used five-screen tapeslide and the other used TV in the form of videotape recording.

The study comprised ten diagnostic tests in the course, five for each method. Evaluation was made on the basis of test points and attitude tests.

There was no significant difference in the measuring capacity of the two methods, but the students' attitudes were in favour of the tapeslide form of presentation.

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APPENDIX

1. INTRODUCTION

Today there is an increasing demand for education. With a limited number of teachers there is a need for more rational teaching methods.

Centrally produced course material with a systematic use of audiovisual aids and with built-in diagnostic tests is one way of relieving the teacher of much routine work.

At the Royal Institute of Technology courses of this kind in electronics have been developed by the PE Group. Special efforts have been devoted to the development of the feedback technique necessary for process control (report PE-8).

1.1 Course in Transistor Pulse Circuits

In the autumn of 1967 an electronics course with 14 uniformly built-up weekly packages was developed in accordance with the package model in figure 1. Each package started with a motivating TV programme (TV) followed by independent studies (IS) in the textbook. This was checked with a diagnostic test (DT) in class followed by a discussion (D). Each package then concluded with calculation exercises (C) and laboratory experiments (LAB).

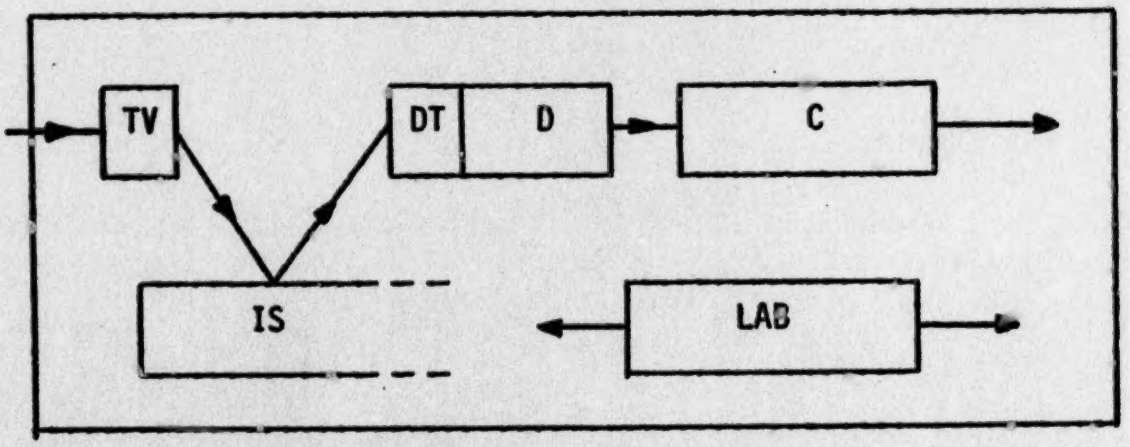


Fig. 1 Package model for the use of different activities in the electronics course.

The television programmes were produced in cooperation with TRU (The Commission for Television and Radio in Education) which also supported the development of the diagnostic tests.

The course was run for the first time in the spring of 1968 as an experiment in the systematic use of TV programmes in the teaching of electronics. The results of the course were the same although the ordinary lecturing time was cut by 75 % and the remaining 25 % was used for TV programmes and diagnostic tests with discussions (report PE-4).

1.2 Diagnostic tests

The diagnostic test as shown in figure 1 was introduced in the model for several reasons:

1. To get a continuous follow-up of students´ results for evaluation of the teaching model.
2. To give the teacher an immediate feedback on weak points, thus providing him with a better basis for adaptation of the teaching to students´ needs.
3. Individual feedback to students.

To make this feedback quick, the test used the multiple-choice technique and five-screen slide projection. Each question was presented on one screen and the four alternatives on the others. The running of the test was programmed from tape to make the test situation reproducible.

The use of multiple choice questions made it possible to correct the answer sheets during a short break and then to comment on the result, especially on the weak points. The test led to very active discussions on the subject and was very much appreciated by the students (report PE-3).

Later in 1968 an electronic responder system, ESAU, was developed. This facilitated the running of the test and permitted direct comments on each question and on the answers (report PE-7).

2. PROBLEM

2.1 Different media for test presentation

The reason for the use of five screens for test presentation was that, combined with an electronic responder system, the distractors could be removed at the end of the question. This would reinforce the right answer and avoid learning the wrong answers.

The rather large projection area also facilitated reading of the question as well as the alternative answers.

A five screen slide projection system is, of course, neither easy to handle nor cheap to install, and this restricted the technique.

Many other forms of presentation are, of course, possible, e.g. stencil, tapeslide with one projector, overhead, TV (live or taped).

2.2 TV versus tapeslide

An interesting alternative is tests recorded on videotape. The TV presentation of the test is both reproducible and easy to distribute over CCTV (Closed Circuit Television) network. Teaching at the new Institute of Technology in Linköping is to a large extent based on CCTV. On courses with more than 270 students (the largest lecture hall has 270 seats) there will be TV lectures in smaller groups. For this kind of teaching TV is the natural choice for presentation if programmed diagnostic tests are to be used.

The main differences between the two forms of presentation are:

1. Five screen tapeslide has a much larger projection area than TV.
2. Question and alternative answers can be shown at the same time with slides, which is not always the case with TV. The small TV screen restricts the amount of information presented at the same time.

These restrictions in TV presentation are liable to affect the measuring capacity of the test and also student attitudes to the diagnostic tests in a negative direction.

For this reason it is of interest to study the question: To what extent does TV presentation of diagnostic tests differ from five screen tapeslide presentation in cognitive measurement capacity, and what are student attitudes to these forms of presentation of the tests?

3. METHOD

The role of the diagnostic test is to assess the students' cognitive level on the week's subject, thus to give both student and teachers an idea of the points on which greater efforts required.

In this special study the result used from the test is only the mean percentage of right answers. The level of this percentage depends on the course material, the students' preparation time, the difficulty of the questions, how the questions are presented, and the time for answering etc.

This result from the test is a relevant measure of the effect of the form of presentation of the test, if the other variables can be controlled.

The way in which an attempt to do this has been made is described below. The choice of a suitable course and the experimental design are here of main interest.

The practical details will be dealt under Preparation of diagnostic tests.

Student attitudes to the tests are, of course, important, as they influence the way the feedback to the students works, and assessment of student attitudes is also discussed.

3.1 Course and students

To be able to compare different forms of presentation for diagnostic tests the above mentioned transistor pulse circuits course was used. This course already had a set of evaluated diagnostic tests produced for five screen tapeslide presentation. To make a comparison between the forms of presentation in the ordinary teaching situation, tests produced on TV (but with the same questions as before) could be used.

An experiment of this kind was carried out on the transistor pulse circuits course during the spring of 1968. The course was being run for the second year and was taken by 186 students in E_2 (second year, Electrical Engineering line).

The course was well suited for this study because it had been thoroughly evaluated on two runs with altogether about 300 students in the previous year (report PE-4).

The electronic responder system ESAU was ready for use on this course, and the tests were thus programmed with direct comments on each question.

3.2 Design

As mentioned above, several factors influence the test result. To isolate the form of presentation factor as well as possible, the following design was used.

From the 14 packages of the course only 10 were used for the study. Numbers 1, 12, 13 and 14 were changed from the previous year and therefore not included.

To get the two forms of presentation evenly distributed over the different parts of the course, every second package used tapeslide and the others TV for test presentation.

Presentation form	Test No.	
Tapeslide	2 4 6 8 10	even
TV	3 5 7 9 11	odd

Tests with even numbers (called "even") were programmed on tapeslide and tests with odd numbers (called "odd") on TV.

This design makes it possible for the same students to be measured with both presentation forms and anlalysed both individually and in groups. The results from E_2-68 show that the mean result on "odd" and "even" tests are practically the same (shown in table 1).

Table 1. Mean results from diagnostic test E_2-68

Test No.	2	3	4	5	6	7	8	9	10	11	odd	even
Mean % right answers	55	56	76	72	41	51	72	56	51	51	57.2	59.0

The design also makes it possible for the same students to compare the methods in attitude tests.

3.3 Preparation of diagnostic tests

To be able to compare the different tests, the same questions were used as in the previous year.

Some problems arose, as the questions sometimes contained too much information to be displayed on the TV screen at the same time.

Thus the TV presentation of the test required a special technique. The question was shown first, and then the alternative answers. This sequence was repeated a couple of times. The questions were always put in short form at the top of the picture to ensure continuity.

An example of how one question was transferred from tapeslide form to TV is shown in figures 1 and 2. The different sizes of the frames are not true to the real test situation, where the slide screens are equal and much larger than the TV screens. To compensate for this, five TV monitors were distributed throughout the lecture hall to obtain a maximum viewing distance of 6 m.

Extra time for answering (5 s) is given in the TV form because of the alternation of information.

a.

$$\overline{ABC + DEF}$$

b.

$$\overline{ABC \cdot DEF}$$

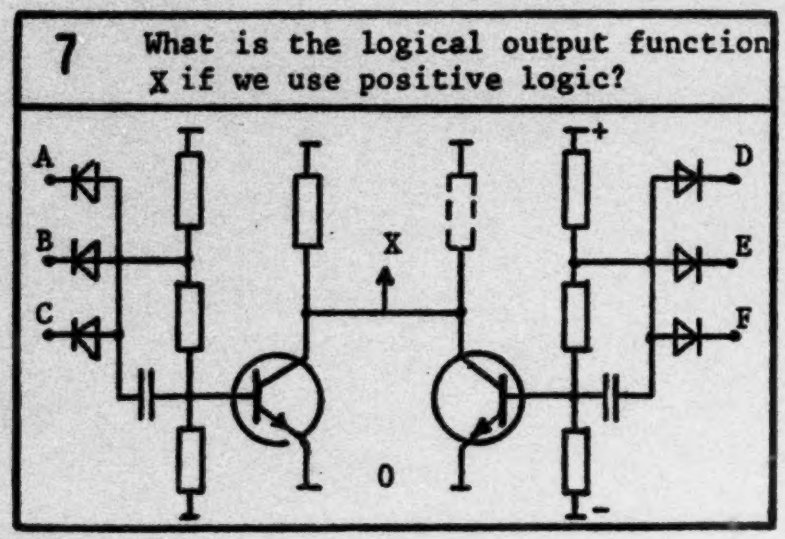
c.

$$\overline{(A+B+C)+(D+E+F)}$$

d.

$$\overline{(A+B+C)\cdot(D+E+F)}$$

Question:



Question 7: Here are two logic modules of the same kind with the outputs connected in parallel. What is the logical output function X if we use positive logic?

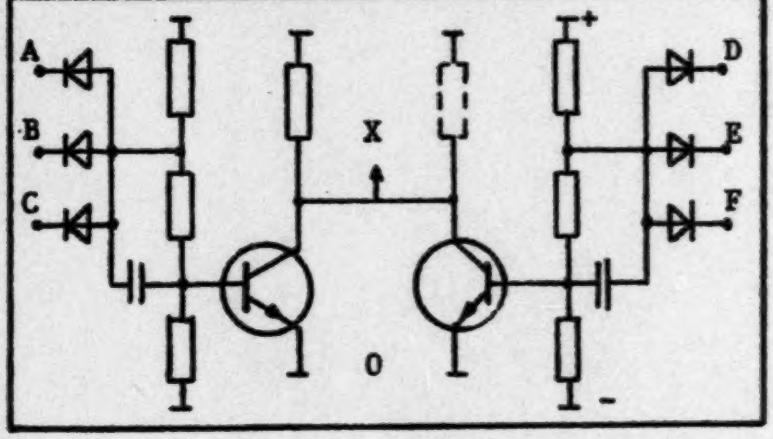
60 s (time for answering)
Ding
3 s
Dong (end of time for answering)

Comments: The right answer is a. The modules are NAND circuits because only if all of A, B and C are high will the transistor saturate and make the output low.
If any of the output transistors in parallel is saturated, the output X will be low. The output X is thus the inverted sum of two AND-functions.

Fig. 1 An example of a question programmed for five-screen tapeslide (manuscript form).

Question:

7 What is the logical output function X if we use positive logic?



Alternatives:

7 What is the logical output function X if we use positive logic?

a. $\overline{ABC + DEF}$

b. $\overline{ABC \cdot DEF}$

c. $\overline{(A+B+C) + (D+E+F)}$

d. $\overline{(A+B+C) \cdot (D+E+F)}$

Question 7

Here are two logic modules of the same kind with the outputs connected in parallel.
What is the logical output function X if we use positive logic?

Question	20 s	
Answer	20 s	(time for
Question	15 s	answering)
Answer	10 s	

Ding

3 s

Dong (end of time for answering)

Comments

The right answer is a. The modules are NAND circuits because only if all of A, B and C are high will the transistor saturate and make the output low.
If any of the output transistors in parallel is saturated, the output X will be low. The output X is thus the inverted sum of two AND functions.

Fig. 2 The same question as in figure 1 programmed for TV (manuscript form).

3.4 Attitude tests

There are two important criteria of how a diagnostic test works. One is how it measures and the other is how it is accepted by the students.

The first part can be dealt with by analysing the test results. The other can be assessed by attitude tests. For this purpose two attitude tests were run, the first (I February-69) after package 5 and the second (II May-69) at the end of the course. These tests are reproduced in report PE-8 together with the distribution of answers. Some of the questions will be given later in this report.

The attitudes will also affect attendance, as there is no compulsion to attend lectures. Poor programmes will decrease attendance, as the students at the Institute are rational beings and try to optimize their efforts to fulfil their own objectives.

4. RESULTS

4.1 Diagnostic test results E_2-69

In table 2 below the mean results from the diagnostic tests run both for E_2-68 and E_2-69 are given.

The percentage of right answers is calculated on the total number of students attending the test.

Table 2. Diagnostic test results from E_2-68 and E_2-69

Test No.		2	3	4	5	6	7	8	9	10	11
Mean % right answer	E_2-69	66	47	58	67	57	60	67	55	56	68
	E_2-68	55	56	76	72	41	51	72	56	51	51

As a first check the mean results from -68 and -69 are compared in table 3. It will be seen that the overall results on even and odd tests are the same for the two years.

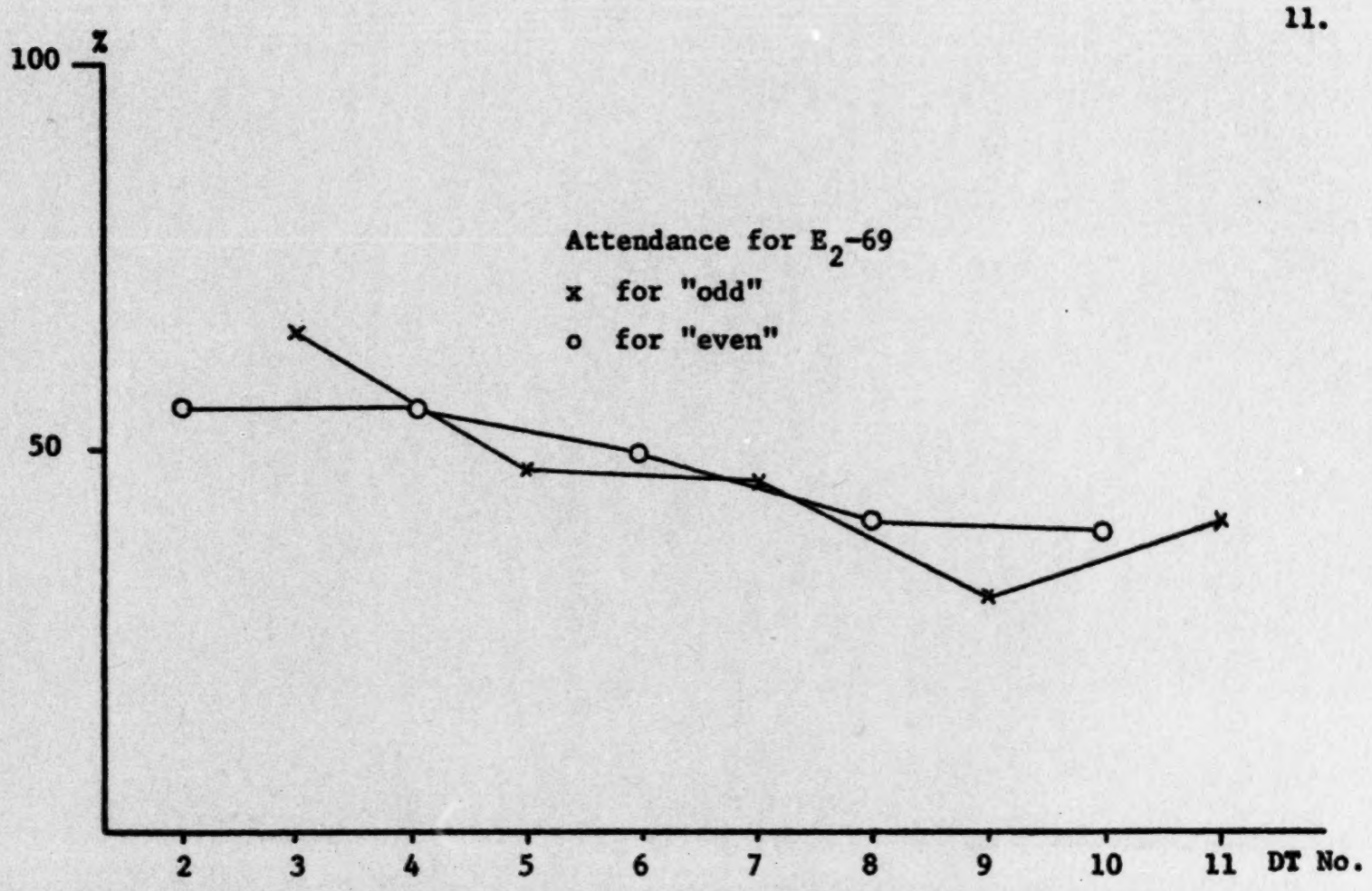
Table 3. Mean results on even and odd diagnostic tests

Tests	even = tapeslide		odd = TV
Mean % right answers	E_2-69	60.8	59.4
	E_2-68	59.0	57.2

Another factor of interest to compare is how the attendance at even and odd tests is distributed in the two courses. This is shown in table 4 and figure 3.

Table 4. Attendance at diagnostic tests E_2-68 and E_2-69

Test No.		2	3	4	5	6	7	8	9	10	11
Attendance %	E_2-69	55	65	55	47	49	45	40	30	39	40
	E_2-68	75	72	62	57	51	42	56	43	39	34



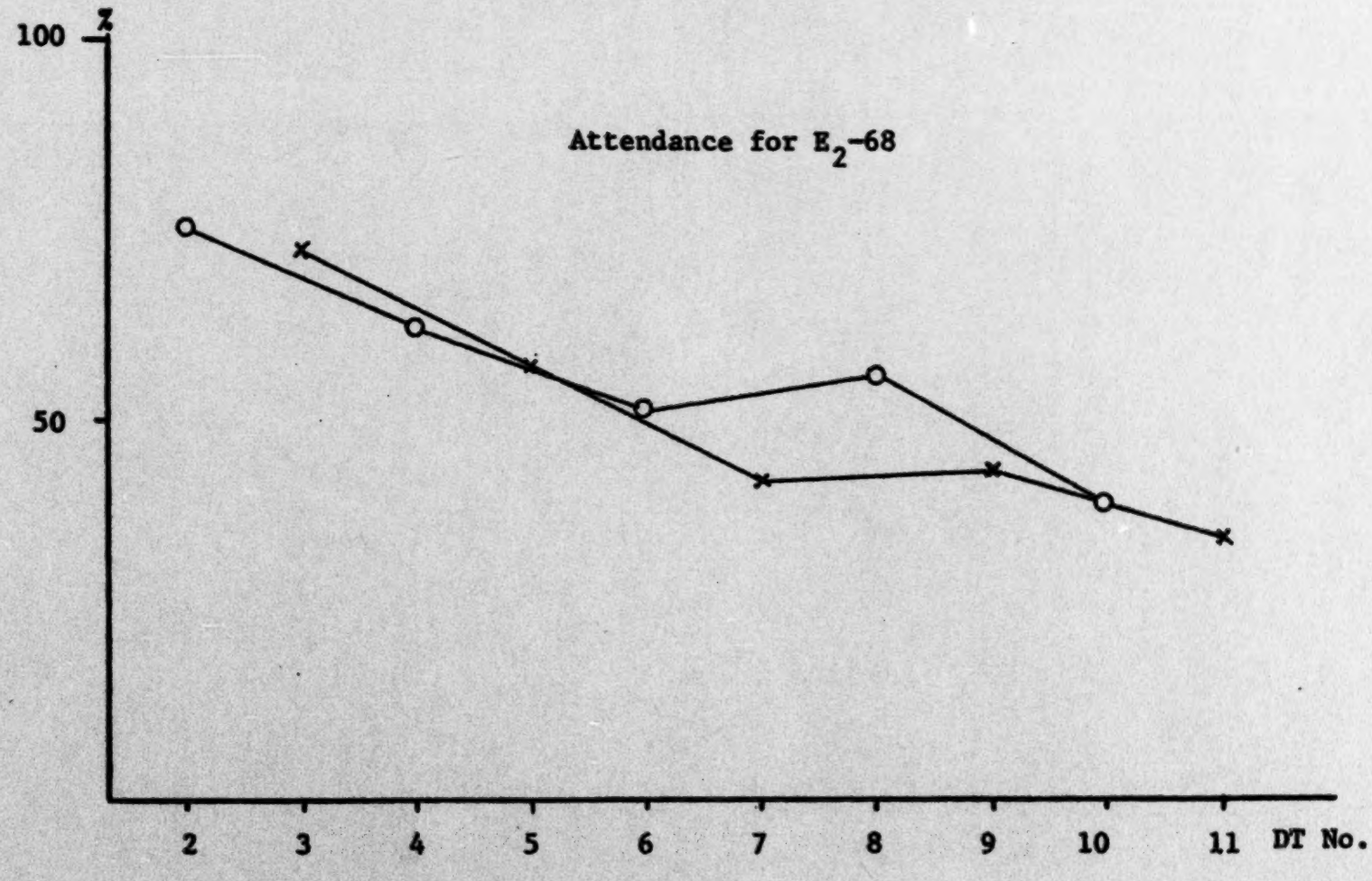


Fig. 3 Attendance for even and odd tests for E_2-69 and E_2-68. The attendance level is low but normal, because lectures are not compulsory at the Royal Institute of Technology.

In table 5 the levels of attendance for even and odd tests are given.

Table 5. Mean attendance at even and odd diagnostic tests

Tests		even	odd
Attendance	E_2-69	47.6	45.4
%	E_2-68	56.6	49.6

4.2 Statistical analysis

For the direct comparison of the two methods of presentation only those students who have attended all ten tests will be taken into account. In this way the expected means of even and odd tests are the same.

The results from even and odd are correlated because the same individuals are involved. This effect can be eliminated in the calculations by using the difference between even and odd test results for each individual.

Fourteen students attended all ten tests and their mean results on "even" and "odd" are given in table 6, where the difference E - O = D and D^2 are given.

Table 6. Mean test results for students who attended all ten tests for E_2-69

Test results		Difference	
Odd	Even	O - E = D	D^2
5.8	6.0	-0.2	0.04
5.2	4.2	1.0	1.00
4.0	4.0	0.0	0.00
4.2	4.0	0.2	0.04
3.6	5.4	-1.8	3.24
3.6	5.4	-1.8	3.24
4.8	4.4	0.4	0.16
5.2	4.4	0.8	0.64
4.6	4.4	0.2	0.04
6.0	5.8	0.2	0.04
3.8	4.0	-0.2	0.04
4.4	3.6	0.8	0.64
5.8	6.4	-0.6	0.36
4.2	5.4	-1.2	1.44
		Σ -2.2	10.92

$\bar{D} = -\frac{2.2}{14} = -0.31$ ($\hat{=}$ -4.4 % difference in mean percentage of right answers)

This mean deviation can be tested for significance by computing the corresponding t value (formula 11.9 in Ferguson):

$$t = \frac{\Sigma D}{\sqrt{[N\Sigma D^2 - (\Sigma D)^2]/(N-1)}} =$$

$$= \frac{-2.2}{\sqrt{[14 \cdot 10.92 - (-2.2)^2]/(14-1)}} = -0.65$$

With N-1=13 degrees of freedom the t value needed for significance at 5 % level in a two tailed test is 2.16 which is not reached in this case.

Thus there is no support in this study for the assumption that the two forms of presentation differ significantly in cognitive measurement capacity.

4.3 Attitudes

The two attitude tests, I February -69 and II May -69, included some questions on the diagnostic tests and the form of presentation. The results from these questions are presented below. (The complete tests are given in appendix 8 in report PE-8.)

I February-69 II May-69

I:1 and II:1 What is your overall impression of this TV teaching compared with average conventional teaching?

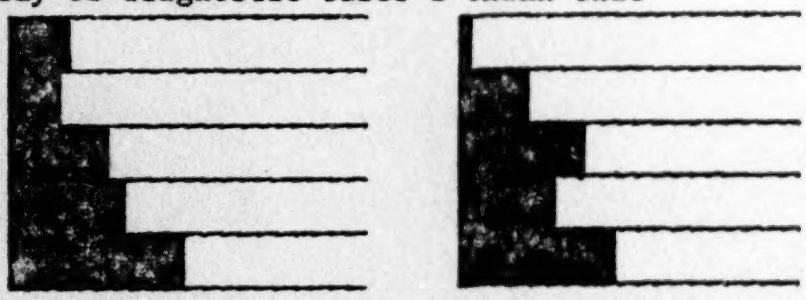
a) much better
b) rather better
c) neither better nor worse
d) rather worse
e) much worse

I:2 and II:11 As aid in independent study the diagnostic tests were

a) very good
b) fairly good
c) neither good nor poor
d) rather poor
e) much poor

I:7 and II:12 Comparing slides and TV for display of diagnostic tests I think that

a) TV is much better
b) TV is rather better
c) TV is as good as
d) slides are rather better
e) slides are much better



These answers show a significant positive attitude to the course as a whole but this attitude is slightly decreased towards the end of the course (I:1, II:1).

The diagnostic tests were of great help for independent studies. This attitude is also slightly decreased towards the end of the course (I:2, II:11).

Comparing slides and TV for test presentation, there is clear majority in favour of slides. This is accentuated at the end of the course (I:7, II:12).

5. DISCUSSION

Two different forms of presentation of programmed diagnostic tests have been compared.

The comparison did not show any significant differences in mean test scores either for the total group or for the students attending all tests. The effects studied were rather comprehensive. The differences between the forms of presentation may be referred to several factors: media (slide - TV), readability, presentation sequence, attitudes to the media itself.

As the study was carried out in the regular teaching at the Royal Institute of Technology, no real experiment was possible in which these factors could be isolated.

Studying the decreasing attendance frequency for the two courses, the tendency is the same but the mean level somewhat lower for E_2-69. This can partly be accounted for by the negative attitude to TV presentation of the diagnostic tests, as shown in attitude questions I:7 and II:12.

The fact that the attendance at odd tests is somewhat lower than at the even tests for both courses can be explained by the decreasing attendance towards the end of the term, as the odd tests are one test behind the even ones.

Student attitudes to the course in general have been positive all through (questions I:1 and II:1), which makes it easier to evaluate the negative attitudes.

An important factor is how the tests have influenced the motivation for independent studies (question I:2 and II:11). The slightly decreasing positive attitude in this report can be referred partly to the negative attitude to TV presentation of the tests and partly to the fact that independent study has increasingly become the ordinary method of studying (report PE-8).

On the direct question about the two forms of presentation, the students think that slides are better than TV. This is accentuated at the end of the course (question I:7 and II:12). This can be compared with the difference between colour and black/white TV in teaching. The cognitive effects are often found to bee the same but attitudes to colour TV are more favourable.

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PRIMARY DATA FROM E_2-69

Number of right answers ≤ 7
Absent ⟹ -1

Diagnostic test No.												Mean.		Attendance.	
1	2	3	4	5	6	7	8	9	10	11	13	ODD	EVEN	ODD	EVEN
2	-1	6	5	5	7	5	7	7	4	7	6	6,00	5,75	5	4
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0,00	0,00	0	0
-1	3	3	1	6	4	5	-1	5	4	3	2	5,00	3,00	5	4
6	4	2	-1	4	-1	-1	-1	3	4	4	-1	3,25	4,00	4	2
5	5	2	3	4	7	-1	-1	-1	6	1	-1	3,00	5,25	2	4
-1	2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0,00	2,00	0	1
-1	8	6	5	6	-1	-1	-1	-1	-1	-1	-1	6,00	6,50	2	2
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0,00	0,00	0	0
5	7	4	5	6	5	7	7	6	6	6	7	5,80	6,00	5	5
6	4	3	4	3	-1	-1	4	3	-1	-1	-1	3,00	4,00	3	3
4	4	5	2	-1	-1	-1	3	0	4	-1	-1	2,50	3,25	2	4
-1	-1	5	5	4	-1	-1	-1	3	-1	-1	-1	4,00	5,00	3	1
2	2	4	1	-1	-1	-1	-1	-1	-1	-1	-1	4,00	1,50	1	2
6	5	4	4	5	4	3	4	-1	3	-1	4	4,00	4,00	3	5
7	5	3	4	7	-1	4	4	-1	-1	7	4	5,25	4,33	4	3
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5	-1	1	4	6	6	1	-1	-1	-1	-1	-1	2,67	5,00	3	2
5	7	2	4	4	5	2	-1	-1	-1	-1	-1	2,67	5,33	3	3
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